Repeated Distraction Osteogenesis for Excessive Vertical Alveolar Augmentation: A Case Report

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In this article, a procedure involving 2-stage alveolar distraction osteogenesis using eccentric distraction devices for the augmentation of resorbed transplanted iliac bone following mandibular tumor resection is presented. A 6-month consolidation period was allowed between the first and second distractions, and endosseous implants were placed 4 months after the second distraction. Computerized tomographic images obtained before the implantation revealed that, 10 months after the first distraction, the bone generated still showed lower density compared with the basal bone, but the bone from both distractions showed enough maturity for implantation. It may be concluded that 2-stage alveolar distraction osteogenesis can be a useful and safe procedure for excessive alveolar lengthening if a sufficiently long consolidation period is allowed. (Case Report) INT J ORAL MAXILLOFAC IMPLANTS 2006;21:471–475

Key words: *alveolar augmentation, distraction osteogenesis, eccentric distractors, iliac bone grafting, mandibular resection*

Alveolar augmentation by distraction osteogenesis (DO) can be an effective treatment for reconstructing the atrophic jawbone, and many reports have shown the adequacy of this procedure for the pretreatment stage of oral implant placement.[1–6] This series of treatment can result in a prosthetic treatment solution not only for the edentulous and atrophic mandible but also for functional problems caused by diminished bone height of the reconstructed mandible following mandibular tumor resection.[7–11] All available distraction devices can increase the height of the alveolar bone sufficiently for implant placement. However, some cases require excessive augmentation of alveolar height to obtain an esthetically ideal, functional implant. As the available distraction devices can lengthen by 15 mm, additional treatment may be required to obtain alveolar augmentation of more than 15 mm.

In this article, a case is reported which involved 2-stage augmentation of alveolar bone using extraosseous distraction devices to increase alveolar height more than 15 mm following iliac bone grafting to reconstruct the mandible after partial resection of the mandible because of an ameloblastoma.

CASE REPORT

A 32-year-old Japanese female patient consulted regarding a complaint about prosthetic treatment involving dental implants on April 13, 2003. She had undergone segmental mandibulectomy from the left central incisor to the left retromolar area as the result of a large mandibular ameloblastoma when she was 20 years old. Subsequently, the patient underwent simultaneous mandibular reconstruction by iliac bone grafting and titanium reconstruction plate. Two years after the first operation, the titanium reconstruction plate was removed.

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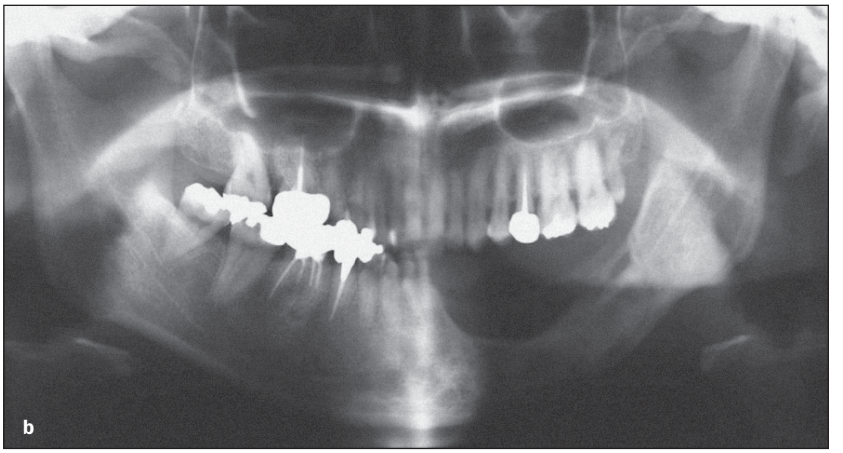


Fig 1 *(a)* Preoperative clinical appearance and *(b)* preoperative panoramic radiograph. Panoramic radiograph shows the resorbed transplanted iliac bone on the left side of the mandible.

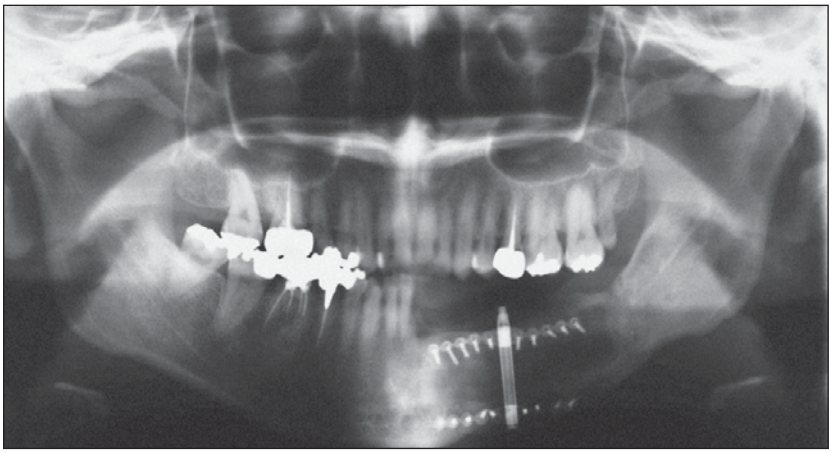


Fig 2 Panoramic radiograph 6 months after the first alveolar vertical distraction osteogenesis. The distraction devices (TRACK 1.5) elevated the alveolar height with an increase of 15 mm (ie, a distracted gap of 15 mm). In the 6-month radiograph, the distracted gap showed increased bone density, and the vertical osteotomy line had disappeared. The vertical dimension of alveolar bone was sufficient for implantation at the molar region but not at the anterior region.

Following the first operation, she underwent prosthetic treatment and was provided with a removable partial denture for the missing teeth, but she had never been satisfied with it because of mobility related to the reduced height of the alveolar ridge in the reconstructed area. She returned to the authors' hospital to undergo prosthetic treatment with dental implants.

Clinical and radiographic examinations revealed a severe height discrepancy of the reconstructed mandibular bone (Figs 1a and 1b), and this condition prompted a treatment plan involving augmentation of the mandible by DO as pretreatment for implant placement. The necessary height for the ideal mandible dimension for dental implants was estimated to be 20 mm at the anterior portion of the left hemimandible and 15 mm in the second molar region.

On September 1, 2003, the first operation for alveolar augmentation by DO was performed under general anesthesia. The operation was performed according to the routine protocol for DO using a cylindric device (Tissue Regeneration by Alveolar Callusdistraction Köln [TRACK] 1.5; Martin, Tuttlingen, Germany) for vertical alveolar distraction osteogenesis. Distraction was initiated 7 days after the operation at a rate of 1 mm per day. The distraction was continued until the planned advancement (15 mm) was completed.

Three months after completion of the distraction, although the radiographic examination revealed increases of density in the distracted gap, it did not appear to be adequate to perform a second distraction because the subsequent procedure would require an anchorage at this gap. A further 3 months after the operation, radiography revealed increased density of the distracted gap (Fig 2), and removal of the previous distraction device and the operation necessary for additional alveolar bone distraction using TRACK 1.0 was performed under neuroleptanesthesia on April 7, 2004. During the osteotomy, which continued from the anterior to the premolar region, the width of the matured buccal cortex of the distracted gap was observed to be sufficient to secure the secondary distraction device (Fig 3). The distraction was started 7 days after the operation at a rate of 1 mm per day. The distraction device was finally lengthened by 15 mm (Figs 4a and 4b).

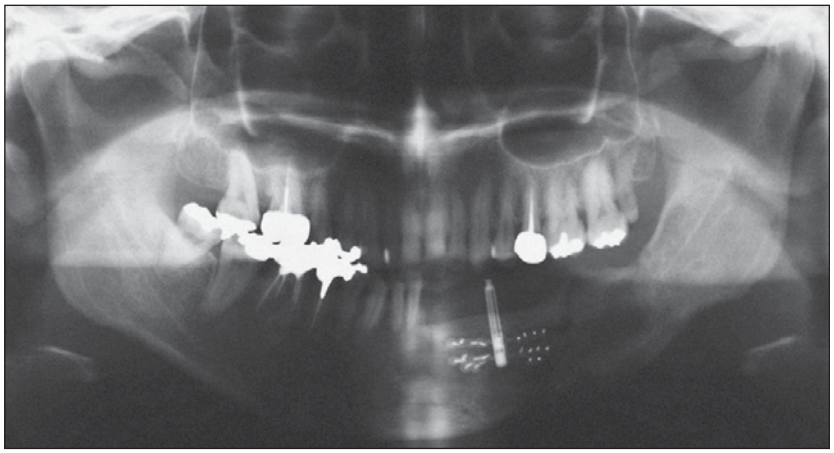


Fig 3 Panoramic radiograph taken immediately after the second alveolar vertical distraction osteogenesis. The alveolar osteotomy continued from the anterior to the left premolar region, and the TRACK 1.0 was secured. Anchorage of the basal bone was located in the gap created by the previous distraction.

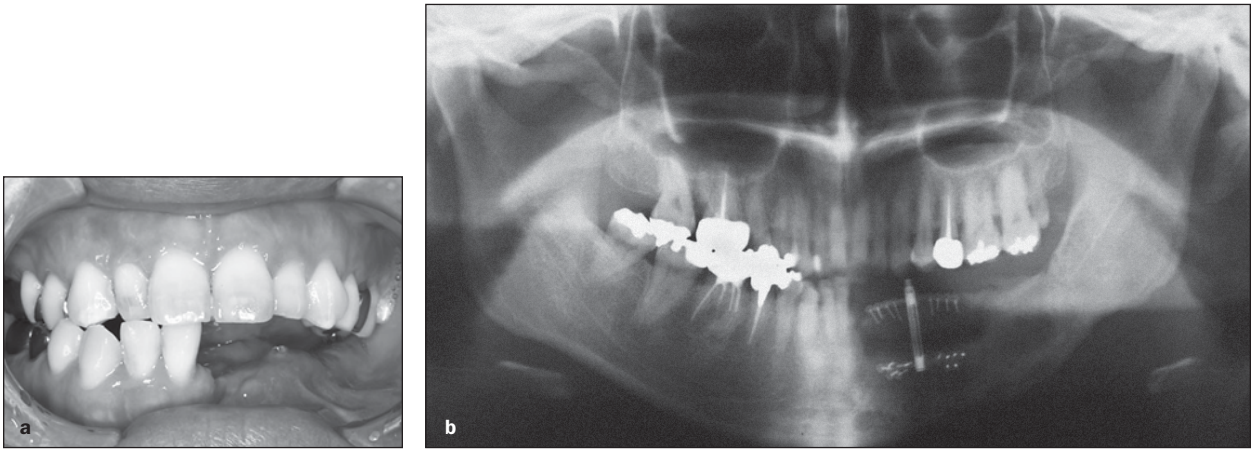


Fig 4 *(a)* Clinical appearance and *(b)* panoramic radiograph 3 months after the second vertical alveolar distraction osteogenesis procedure (10 months after the first distraction). Sufficient alveolar height for implantation was obtained at the anterior portion of the mandible. However, the screws securing the upper part of the plate of the distraction device had changed their direction inferiorly, resulting in the deviation of the devices and the alveolar ridge. This deviation was discovered at this 3-month follow-up. The bone generated during the first distraction showed similar density to the basal bone, and that generated during the second distraction showed slightly increased density.

After 4 months of consolidation, a dental computerized tomographic (CT) scan was obtained and compared with the dental CT taken before the first DO (Figs 5a and 5b). This CT examination revealed sufficient bone generation, with a maximum of 20 mm of bone height increase in the premolar region (Fig 5b). However, deviation of the distracted alveolar ridge onto the lingual side was observed.

The shape of the alveolar ridge was diagnosed to be appropriate, if not ideal, for the placement of implants, and removal of the distraction devices and simultaneous placement of 5 endosseous Brånemark System implants (Nobel Biocare, Göteborg, Sweden) was performed under neuroleptanesthesia on August 23, 2004. Immediate provisional restorations were fabricated, and the definitive metal-ceramic restoration was placed 6 months later. Acceptable esthetic and functional results were obtained, and the postoperative course was uneventful (Figs 6a and 6b).

DISCUSSION

The recent introduction of microvascular techniques in the oral and maxillofacial field has provided the important contribution of vascularized bone transplantation, eg, the use of the fibula for large mandibular defects following mandibular tumor resections.[7–9] However, free iliac bone transplantation,[10,11] which is a classical basic procedure for mandibular reconstruction, is still common. There is no doubt that all of these reconstruction procedures yield sufficiently esthetic and functional results, but it is also true that most patients who have residual dentition on the unoperated side tend to require some special prosthetic treatment because of the relevant step at the graft-to-residual-stump level.[9] To solve these prosthetic and esthetic problems, dental implant treatment is recommended, but additional augmentation of the alveolar bone is often neces-

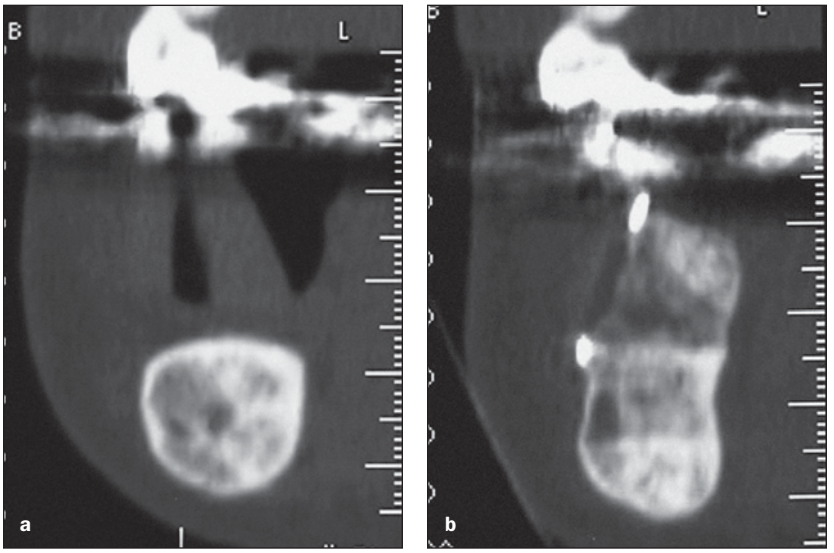
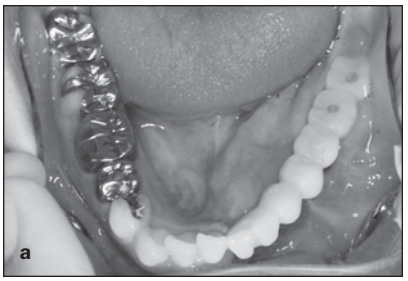


Fig 5 *(a)* Dental CT obtained before the series of operations and *(b)* 1 obtained 4 months after the second vertical distraction osteogenesis. Direct measurement of the height on the 2 radiographs revealed that mandibular height was lengthened 20 mm vertically by this series of surgical treatments. The CT image obtained after the second distraction osteogenesis revealed 4 layers in the mandible and also showed the different densities of the 2 areas of distracted bone. The lower part of the distracted gap was mature at 10 months after distraction; the upper bone was mature at 4 months after distraction. In the lower layer high radiopacity was observed in bone marrow and the thickened lateral cortex, but in the upper layer the opacities were less. In the upper layer, the elongated dimension at the lingual side was shorter than that at the buccal side, highlighting the deviation of the distraction device and augmented alveolar ridge to the lingual side.



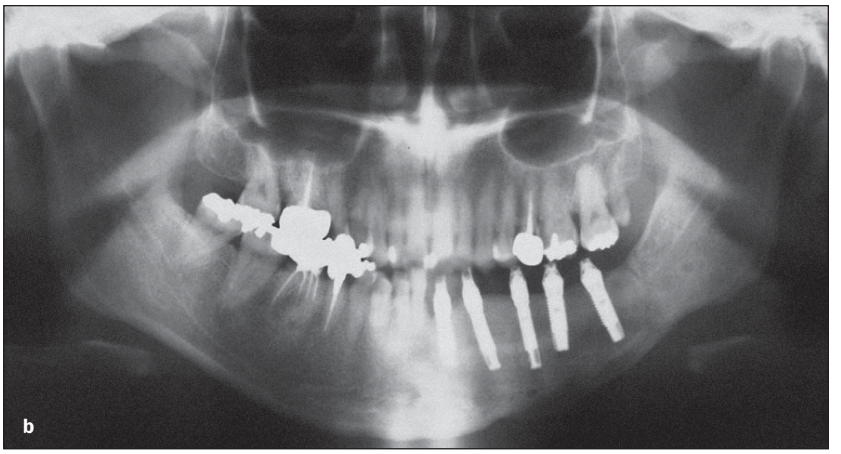


Fig 6 *(a)* Clinical appearance and *(b)* panoramic radiography after treatment termination (1 year after the placement of dental implants).

sary because of the height discrepancy of the alveolar ridge in such a reconstructed mandible.

Some surgical procedures[12,13] have been advocated to augment the alveolar height, but alveolar augmentation by distraction osteogenesis has the advantages of eliminating the risk of complications at the site of the donor bone and increasing the potential for augmentation. A number of systems[1,3,4–9,10] have been developed for DO, and each system has characteristic advantages.[1] All available devices, however, can lengthen to a maximum of 15 mm, which is regarded as sufficient for implant placement. As the presented case required greater alveolar augmentation, about 20 mm of lengthening in the premolar region of the mandible, a 2-step augmentation procedure was planned. As this procedure required easy removal of the previous device without damage to the bone generated by the first DO procedure, the eccentric distractor system was used.

To achieve 2-stage alveolar distraction, the most important factor is the bone maturity of the distracted gap, and maturity can be ensured by allowing a sufficient consolidation period after DO. Clinically, special attention has been paid to this period prior to implantation, and it is now believed that 2 to 3 months is enough to allow sufficient maturity for implantation.[2–9,11] However, this period may not be adequate for secondary DO, because the second DO requires anchorage of distraction devices at the buccal cortex of the distracted gap. Some clinical and experimental studies[3,14–16] have shown bone maturity in the distracted gap following alveolar DO, but not many studies have analyzed the maturation over the long term. Gaggl and associates[16] analyzed detailed histologic findings of distraction gaps following alveolar augmentation in sheep and found mature bone in the central region 6 months after DO, although restructuring was also presented at the edge of the distraction region.

In the present case, the panoramic radiograph obtained 6 months after the first DO revealed increased homogeneous density of the distracted gap and disappearance of osteotomy lines. Based on experimental studies in the literature already described in this study, the radiographic findings, and intraoperative findings during the osteotomy, it was decided that 6 months may be a sufficient consolidation period for secondary DO.

Deviation of the distracted segment onto the lingual side was observed in the anterior part of the hemimandible during the second stage of DO. Garcia and associates[6] classified the morphologic changes of the distracted alveolar ridge and showed that deviation onto the lingual side was found in 4 of 17 cases. They suggested an influence of the cheek movement in this situation. In the presented case, this morphologic change was found during the second DO, which was carried out using a smaller distraction device (TRACK 1.0). Neither deviation of alveolar ridge nor deformation of the device were found after the first DO using the TRACK 1.5 device. This result may reflect a difference in the mechanical strength of the 2 different sizes of the device, as well as the fact that the distracted segment positioned higher may be more likely to be affected by strong forces from the lip and cheek. Additionally, the lingual side of the alveolar ridge was covered by movable membrane originating from the oral floor and also was attached to lingual muscles, which tended to pull the distracted segment toward the inside by tongue movement.

In conclusion, the ideal treatment for the presented case would have been to use distraction devices which could lengthen by more than 15 mm. Nevertheless, 2-stage DO can be a useful procedure for excessive alveolar lengthening if sufficient consolidation periods and appropriate devices are used.

REFERENCES

1. McAllister BS, Gaffaney TE. Distraction osteogenesis for vertical bone augmentation prior to oral implant reconstruction. Periodontol 2000 2003;33:54–65.
2. Raghoebar GM, Liem RSB, Vissink A. Vertical distraction of the severely resorbed edentulous mandible. A clinical, histological and electron microscopic study of 10 treated cases. Clin Oral Implants Res 2002;13:558–565.
3. Zaffe D, Bertoldi C, Palumbo C, Consolo U. Morphofunctional and clinical study on mandibular alveolar distraction osteogenesis. Clin Oral Implants Res 2002;12:550–557.
4. Rachmiel A, Srouji S, Peled M. Alveolar ridge augmentation by distraction osteogenesis. Int J Oral Maxillofac Surg 2001;30: 510–517.
5. Uckan S, Haydar SG, Dolanmaz D. Alveolar distraction: Analysis of 10 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:561–565.
6. Garcia AG, Martin MS, Vila PG, Rey JM. A preliminary morphologic classification of the alveolar ridge after distraction osteogenesis. J Oral Maxillofac Surg 2004;62:563–566.
7. Klesper B, Lazar F, Siessegger M, Hidding J, Zoller JE. Vertical distraction osteogenesis of fibula transplants for mandibular reconstruction—A preliminary study. J Craniomaxillofac Surg 2002;30:280–285.
8. Nocini PF, Wangerin K, Albanese M, Kretschmer W, Cortelazzi R. Vertical distraction of a free vascularized fibula flap in a reconstructed hemimandible: Case report. J Oral Maxillofac Surg 2000;28:20–24.
9. Chiapasco M, Brusati R, Gaioto S. Distraction osteogenesis of fibular revascularized flap for improvement of oral implant positioning in a tumor patient: A case report. J Oral Maxillofac Surg 2000;58:134–140.
10. Fukuda M, Iino M, Ohnuki T, Nagai H, Takahashi T. Vertical alveolar distraction osteogenesis with complications in a reconstructed mandible. J Oral Implantol 2003;29:185–188.
11. Nocini PF, Albanese M, Buttura da Prato E, D'Agostino A. Vertical distraction osteogenesis of the mandible applied to an iliac crest graft: Report of a case. Clin Oral Implants Res 2004; 15:366–370.
12. Von Arx T, Kurt B. Implant placement and simultaneous ridge augmentation using autogenous bone and a micro titanium mesh: A prospective clinical study with 20 implants. Clin Oral Implants Res 1999;10:24–33.
13. Roccuzzo M, Ramieri G, Spada MC, Bianchi SD, Berrone S. Vertical alveolar ridge augmentation by means of a titanium mesh and autogenous bone grafts. Clin Oral Implants Res 2004;15: 73–81.
14. Oda T, Sawaki Y, Ueda M. Experimental alveolar ridge augmentation by distraction osteogenesis using simple device that permits secondary implant placement. Int J Oral Maxillofac Implants 2000;15:95–102.
15. Block MS, Almerico B, Crawford C, Gardiner D, Chang A. Bone response to functioning implants in dog mandibular alveolar ridges augmented with distraction osteogenesis. Int J Oral Maxillofac Implants 1998;13:342–351.
16. Gaggl A, Schultes G, Regauer S, Karcher H. Healing process after alveolar ridge distraction in sheep. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:420–429.